Cytology of some arborescent Leguminosae of Nigeria

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Summary

Cytological studies of 20 tree species of Leguminosae have been carried out for the first time from Nigeria. Chromosome numbers for 9 species are new records. *Haplormosia monophylla* (n = 10) furnishes the first chromosome report for this genus. Four of the investigated species are polyploids. The position of base number(s) in the investigated species is discussed. Pollen fertility, pollen size and pH requirements for the species studied are provided.

Key words: Nigeria Leguminous Trees, Chromosome numbers, Phenology, Pollen size.

Zusammenfassung

An 20 in Nigeria vorkommenden, baumartigen Leguminosenarten wurden zum ersten Mal cytologische Untersuchungen durchgeführt, und ihre Chromosomenzahl mitgeteilt. Von 9 Arten war die Anzahl der Chromosomen bisher nicht bekannt, davon war die Bestimmung der n = 10 Chromosomen von *Haplomorsia monophylla* die erste innerhalb der Gattung *Haplomorsia*. Vier der beschriebenen Arten sind polyploid. Für jede Art wurden ausserdem Pollengröße und -fertilität festgestellt sowie die Bodenansprüche (pH-Wert) mitgeteilt. Abschließend werden die vorliegenden cytologischen Ergebnisse mit früheren Veröffentlichungen verglichen und die Position der Basiszahl der untersuchten Arten diskutiert.

Introduction

Leguminosae, with 650 genera and 18,000 species (Anonymous, 1979) is the third largest family of the flowering plants. Legumes are found in temperature zones, arid zones, highlands, savannas, humid tropic and lowlands; and there are few aquatics (e. g. *Neptunia* spp.). The family *Leguminosae* is second only to grasses as the source of human and animal food. Legumes are also an important source for gums, medicines, dyes, fire woods and luxury-timber (e. g. *Pterocarpus* spp.). In Nigeria, there are about 900 different species of trees (Keay *et al.*, 1964) and of these 180 are leguminous.

For any dendrology project on the improvement of trees, informatons on the phenology, chromosome numbers, chromosome behaviour at meiosis and pollen fertility are essential. There are several investigations on the arborescent taxa of the *Leguminosae* from the Indian subcontinent (Bir and Sidhu 1967, Bir and Kumari 1977, Mehra and Hans 1971, Mehra and Sareen 1973, Nanda 1962, Sharma and Bhattacharya 1958). Inspite of the richness of the West African flora and extreme importance of trees, cytological and phenological informations on the trees are meagre. However, a few chromosome numbers of woody leguminous species have been reported in West Africa (Atchison 1951, Mangenot and Mangenot 1962, Meige 1960, 1962). Ewusie (1968) reported the phenology of 100 woody species from Ghana and out of these 23 are leguminous species.

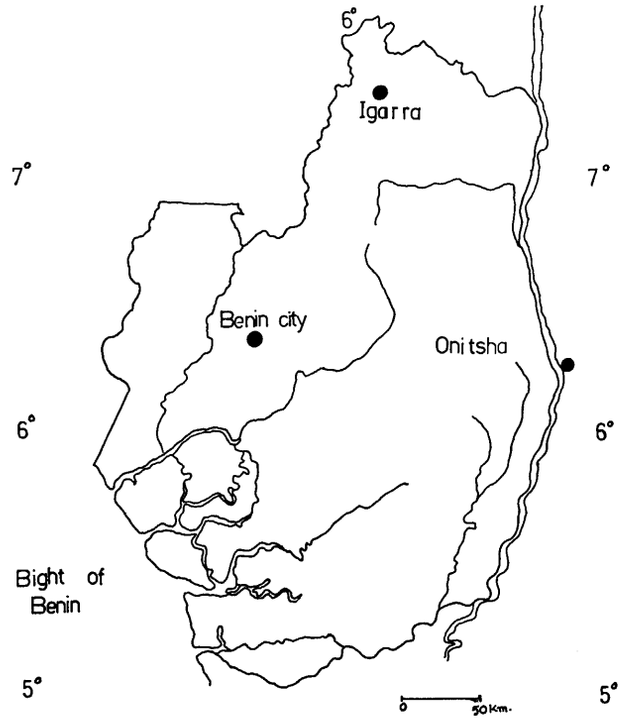
The present paper is a part of a project on the "Biology of Nigerian Legumes" conducted by the senior author which enlists the cytomorphological information of 20 woody species of Leguminosae from Nigeria.

Material and Methods

The materials were collected from different localities of Bendel State, Nigeria (See *Map 1).* The young flower buds were fixed in 1:3 acetic alcohol for 12 hrs. and then transferred to 70% ethylalcohol and stored in the refrigerator until needed. Meiotic and mitotic preparations were made using techniques outlined by Gill (1970, 1971). Camera lucida drawings were made from the permanent slides. Pollen fertility was determined following Gill (1979). For pH determination, the soil samples were taken from the exact site of the plant material and the pH determinations were made following Chapman (1976). The vouchers are preserved in the herbarium of the University of Benin, Nigeria.

Results

The exact locality along with cytological data of the 20 species studied are summarized in *Table 1.* The arrangement of genera and species is alphabetical. Meiosis in all the presently investigated species is normal.



Map. 1. — Map of Study area (Bendel State, Nigeria)

Table 1. — List of species studied along with their chromosome numbers and other supplementary data.

Taxan	Voucher	Origin	Chromosome number	Ploidy level	Previous reports
Bauhinia monandra Kurz.	Husaini 53	Boundry Rd., Benin City	2n = 24	Dip.	2n = 42 (Atchison, 1951) n = 14, 2n = 28 (Sharma and Raju, 1968)
B. tomentosa L.	Husaini 39	Adesuwa Rd., Benin City.	2nd = 28 + 1 fragment	Dip.	n = 14, 2n = 28 (Sharma and Raju, 1968)
Caesalphinia pulcherrima (L.) Sw.					
var. Pink	Husaini 29	Adesuwa Rd., Benin City.	n = 12	Dip.	n = 12 (Atchison, 1951) n = 11 (Bir and Sidhu, 1967)
var. red.	Husaini 97	Ugbowo, Benin City	n = 12	Dip.	n = 12 (Bir and Kumari, 1978) n = 12 (Jacob, 1940)
var. yellow	Husaini 98	Ugbowo Benin City	n = 12	Dip.	n = 12 (Sareen et al., 1974) n = 12 (Senn, 1938) n = 12 (Tixier, 1965)
Caragana arborescens Lam.	Husaini 54	Ekenwan Rd., Benin City	n = 12	Poly.	n = 16 (Frahm - Leliveld, 1962) n = 16 (Moore, 1968)
*Calliandra portoricensis Bth.	Husaini 95	Sapele Rd., Benin City.	n = 22	Poly.	
*Cassia auriculata L.	Husaini 93	3rd Avenue Rd., Benin City	n = 8		
C. planisiliqua Lamk.	Husaini 84	Airport Rd., Benin City.	n = 7	Dip.	n = 14 (Sareen et al., 1974)
Delonix regia (Boj. ex Hook) Raf.	Husaini 49	Ugbowo, Benin City	n = 14	Dip.	2n = 28 (Atchison, 1951) 2n = 28 (Jacob, 1940) n = 14 (Mehra and Sareen, 1973) 2n = 28 (Sanjappa, 1978)
Dialium guineense Willd.	Husaini 89	Adesuwa Rd.,	n = 14	Dip.	2n = 28 (Mangenot and Mangenot, 1957)
*Erythrina vogelii Hook.f.	Husaini 57	Adesuwa Rd., Benin City	n = 12	Dip.	
*Gilbertiodendron mayombense (Pellegr.) J. Leonard	Husaini 94	Uwa Rd., Benin City	n = 12	Dip.	
Gliricidia sepuim (Jacq.) Walp.	Husaini 40	Ugbowo, Benin City	n = 14	Poly.	n = 10 (Gill and Abubakar, 1975 2n = 22 (Rao, 1979) n = 11 (Sarkar et al., 1978)
*Haplormosia monophylla (Harms) Harms	Husaini 76	Ihama St., Benin City	n = 10	Dip.	
*Lonchocarpus laxiflorus Guill. & Perr.	Husaini 80	Onitsha	n = 11	Dip.	
*Millettia chrysophylla Dunn	Husaini 45	Akpakpava Rd., Benin City	n = 18	Poly.	
*M. drastica Welw. ex Bak.	Husaini 69	Igarra	n = 8	Dip.	
Parkinsonia aculeata L.	Husaini 70	Igarra	n = 9	Dip.	2n = 28 (Atchison, 1951) 2n = 28 (Meige, 1962) n = 14 (Mehra and Sareen, 1973)
Peltophorum inerme (Roxb) Llanos	Husaini 50	3rd East Circular Rd., Benin City	n = 7	Dip	2n = 28 (Pantulu, 1942) n = 14 (Sanjappa, 1978)
Pterocarpus echinatus Pers.	Husaini 11	Adesuwa Rd., Benin City	n = 11	Dip.	n = 22 (Sanjappa, 1981)
*Samanea saman (Jaeq.) Merr.	Husaini 4	Nifor Benin City.	2n = 14	Dip.	

* Species investigated for the first time

Bauhinia L. A tropical genus of 300 species (Willis and Airy Shaw, 1973), represented in Nigeria by 4 species.

B. monandra Kurz.

A decorative tree upto 5 m. tall, recognized by pinkish white flower with one long anther. It grows in acidic soils within a pH range of 5—6.5. A diploid chromosome number of 24 *(Fig. 1)* differs from the previous report of 2n = 28 (Sharma and Raju, 1968). Pollen fertility is 97% with an average grain size of 25.8 μm.

Flower: March—May. Fruit: June—October.

B. tomentosa L. (= *Alvesia tomentosa* Britt. et Ross)

An ornamental woody shrub 4m. tall, yellow petals with red blotch on upper petal; fertile stamens 10. It thrives well in acidic soils with a pH of 6.1.

A diploid count of 28 + fragment *(Fig. 2)* was determined Pollen fertility is 96% and pollen grain size is 35.47 μm.

Flower: January—March. Fruit: April—September.

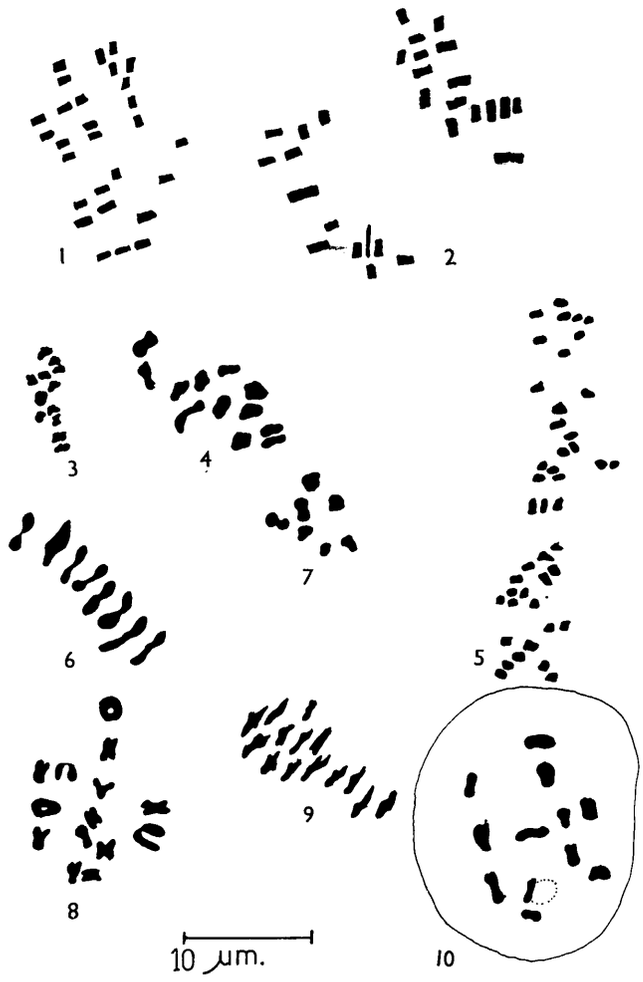


Fig. 1 bis 10:

Fig.	*1. — Bauhinia monandra*	2n = 24, metaphase
	2. — B. tomentosa	2n = 28 + 1 fragment, metaphase
	3. — Caesalpinia pulcherrima	n = 12, metaphase I
	4. — Caragana arborescens	n = 12, metaphase I
	5. — Calliandra portoriensis	n = 22, mixed anaphase I
	6. — Cassia auriculata	n = 8, metaphase I
	7. — C. planisiliqua	n = 7, metaphase I
	8. — Delonix regia	n = 14, metaphase I
	9. — Dialium guineense	n = 14, metaphase I
	10. — Erythrina aogelii	n = 12, metaphase I

Caesalpinia L.

Consists of 100 shrubby species, distributed in tropics and subtropics. In Nigeria, only one species is grown as decorative.

C. pulcherrima (L.) Sw.

It grows best within a pH range of 4.5—6.5. All the three varieties were found to have a haploid number of 12 *(Fig. 3)*. This confirms the earlier reported number of n = 12 by Atchison (1951), Bir and Kumari (1978), Jacob (1940), Sareen *et al.* (1974), Senn (1938), Tixier (1965), Nevertheless, Bir and Sidhu (1967) also reported a haploid number of 11 from North India. Filled pollen is 73% with grain size of 45.15 μm.

Flower and Fruit: Throughout the year.

Caragana Fabr.

An Asian genus of 80 species of trees and shrubs, represented by one species in Nigeria.

C. arborescens Lam.

A small tree of 7m. high with yellow flower and thrives in acid soils with a pH of 5.9. A haploid chromosome number of 12 *(Fig. 4)* was determined which differs from the earlier recorded number of n = 8 (Frahm-Leliveld, 1962, Moore, 1968). Pollen fertility is 93% and pollen grain size is 29.02 μm.

Flower: May—July. Fruit: August—December.

Calliandra Bth.

A tropical genus of 100 species, distributed in warmer regions of the world.

C. portoricensis Bth.

A decorative small tree 6m. tall with white flowers. It grows in acidic soils with pH of 5.0.

A haploid chromosome number of 22 *(Fig. 5)* was determined which appears to be a new report for this species. Filled pollen is 98.2% and grain size is 19.35 μm.

Flower and Fruit: Throughout the year.

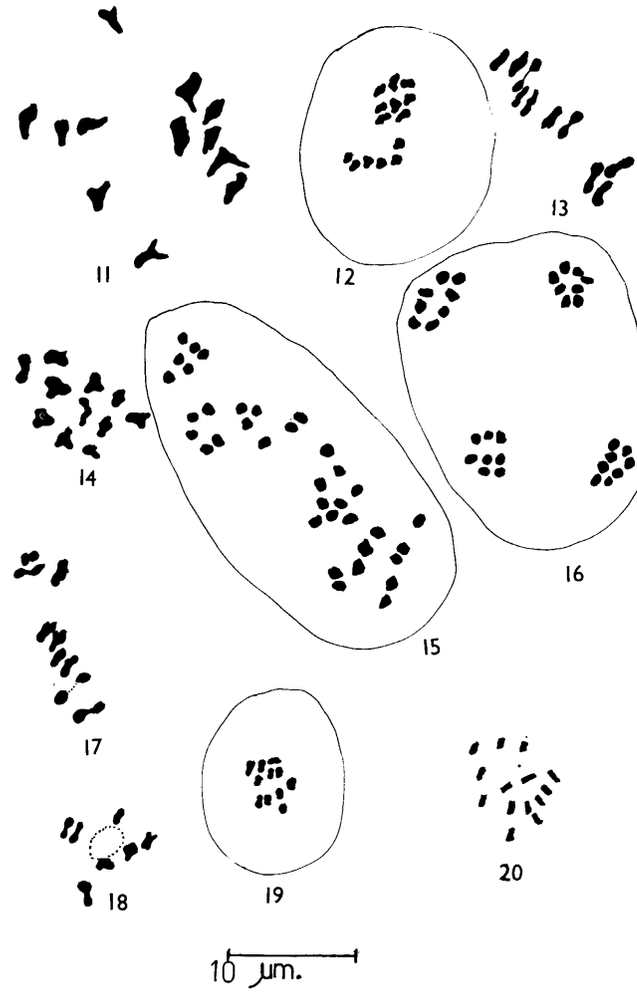


Fig. 11 bis 20:

Fig.	*11. — Gilbertiodendron mayombense*	n = 12, diakienesis
	12. — Gliricidia sepium	n = 14, metaphase I
	13. — Haplormosia mono phylla	n = 10, mixed metaphase I
	14. — Lonchocarpus laxiflorus	n = 11, metaphase I
	15. — Millettia chrysophylla	n = 18, mixed anaphase I
	16. — M. drastica	n = 8, anaphase II
	17. — Parkinsonia aculeata	n = 9, metaphase I
	18. — Peltophorum inerme	n = 7, diakinesis
	19. — Pterocarpus echinatus	n = 11, metaphase I
	20. — Samanea saman	2n = 14, metaphase

Cassia L.

A genus of 500—600 species, distributed in tropical and warm temperate regions of the world. There are 22 indigenous species in Nigeria and many aliens are grown as ornamentals.

C. auriculata L.

A small tree occasionally cultivated, along the roadsides in acidic soils with a pH as low as 4.5.

A haploid chromosome number of 8 *(Fig. 6)* was determined, which is a new record for this species. Pollen stainability is 95.3% and the grain size is 29.02 μm.

Flower: September—December. Fruit: February—May.

C. planisiliqua LAMK.

Small tree of 7m. tall with yellow flowers and grows best in acidic soils with a pH of 5.7.

The present haploid count of 7 *(Fig. 7)* is in line with the base chromosome number of X = 7. SAREEN *et al.* (1974) reported a tetraploid cytotype (n = 14) in this species from North India. Filled pollen is 95%. The grain size is 29.02 μm.

Flower: August—September. Fruit: October—January.

Delonix RAFIN

An African genus of 3 species and represented in Nigeria by one species.

D. regia (BOJ. ex HOOK.) RAF.

A fast growing widely spreading tall 13m. tree with scarlet flowers and having upper petals mottled red and white. It can grow within a soil pH of 4.5—7.5.

The present report of n = 14 *(Fig. 8)* confirms the earlier reports of 2n = 28 (ATCHINSON, 1951, JACOB 1940, MEHRA and SAREEN 1973, SANJAPPA 1978). Filled pollen is 98.3% and pollen grain size is 38.7 μm.

Dialium L.

A tropical genus of 41 species mainly distributed in Africa. In Nigeria there are 3 tree species of ths genus.

D. guineense WILLD.

A tree of 20m. tall with dense leafy crown, greyish smooth bark and distinctive small brownish black velvety fruits. It grows in acidic soils with a pH of 5.3.

Chromosome number of n = 14 *(Fig. 9)* was obtained which confirms the earlier record of 2n = 28 (MANGENOT and MANGENOT 1962). Pollen fertility is 97% and pollen size is 13.0 μm.

Flower: August—November. Fruit: September—April.

Erythrina L.

Composed of 100 tropical and subtropical species, represented in Nigeria by 5 deciduous indigenous tree species and one alien species.

E. vogelii HOOK.F.

A small tree of 8—12 m.tall with large showy scarlet flowers in dense racemes. It can tolerate a pH ranging from 5 to 7.

A haploid chromosome number of n = 12 *(Fig. 10)* was determined at diakiensis. Filled pollen is 96.75% and pollen size is 38.7 μm.

Flower: March—April. Fruit: June—August.

Gilbertiodendron J. LEONARD

A West African genus of 25 species and there are 3 tree species in Nigeria.

G. mayombense (PELLEGR.) J. LEONARD

A tall tree of 20m. high, bark greyish, flaking in patches. It grows in riverside forests in neutral to acidic soil (pH 6.4).

A haploid chromosome count of 12 *(Fig. 11)* is a new report for this species. The only other chromosome number report in this genus is for *G. splendium* (2n = 24) by MANGENOT and MANGENOT (1962). Pollen fertility is 82% and pollen size is 51.6 μm.

Flower: August—September. Fruit: November—January.

Gliricidia KUNTH.

A tropical American genus of 10 species represented in Nigeria by one alien species.

G. sepium (JACQ.) WALP.

An ornamental tree of 8—10 m. tall, characterized by having pink or white flowers in racemes all along the branches on a leafless tree during the blooming period. It grows well in neutral to alkaline soils (pH 7.6).

The present haploid count of 14 *(Fig. 12)* differs from the previous recorded numbers of n = 10 (GILL and ABUBAKAR, 1975) and 2n = 22 (RAO, 1979, SARKAR *et al.*, 1978). Filled pollen is 98.5% and the pollen size is 32.25 μm.

Haplormosia HARMS

A small West African genus of 2 species.

H. monophylla (HARMS) HARMS

A tall tree upto 35m high, bole with buttresses and having blue flowers in lax flowered racemes. It can tolerate a pH as low as 4.6.

A haploid chromosome count of 10 *(Fig. 13)* seems to be a new report for this species and suggests a base number of 7 for this genus. Filled pollen and pollen size are 95% and 25.8 μm. respectively.

Flower: August—October. Fruit: November—January.

Lonchocarpus KUNTH.

A genus of 150 species distributed in tropical America, West Africa and Australia. In Nigeria there are 4 tree species.

L. laxiflorus GUILL. et PERR.

A small tree of 7—8m. tall, bark greyish or yellowish with slight fissueres and with dropping branches. It grows in acidic soils with a pH of 6.4.

A haploid chromosome number of 11 *(Fig. 14)* was determined at metaphase I. Pollen fertility is 96% and pollen grain size is 19.35 μm. This is a new chromosome number for this genus.

Flower: May—July. Fruit: August—September.

Millettia WIGHT et ARN.

Composed of 180 species distributed in tropics and subtropics of the Old World. There are 8 tree species in Nigeria.

M. chrysophylla DUNN

A 17m. tall rain forest tree, thrives best in neutral to alkaline soil (pH 7.2), characterized by having white flowers in terminal panicles upto 30 cm. long.

A haploid chromosome number of 18 *(Fig. 15)* was obtained at mixed anaphase-I. Pollen fertility and pollen size are 94% and 19.35 μm. respectively.

Flower: June—October. Fruit: December.

M. drastica WELW. EX BAK.

A 20m. tall tree of alkaline soils (pH 7.5), with pale blue flowers in racemes.

A haploid chromosome number of 8 was determined at anaphase II *(Fig. 16)*. Pollen fertility is 98% with pollen grain of 25.84 μm.

Flower: February—April. Fruit: May.

Parkinsonia L.

A small tree genus of 2 species distributed in tropical America and Africa. Represented in Nigeria by a single species.

P. aculeata L.

A cultivated 8m. tall tree. It grows best in alkaline soils with a pH of 7.4.

The present report of n = 9 *(Fig. 17)* differs from the previously recorded number of 2n = 28 (Atchinson 1951, Meige 1962, Mehra and Sareen 1973). Pollen fertility is 98% with pollen size of 32.25 μm.

Flower: May—June. Fruit: October—November.

Peltophorum (Vogel) Bth.

A tropical genus of 12 species, represented in Nigeria by two species.

P. inerme (Roxb.) Llanos

A tall spreading tree upto 14m; with showy gamboge yellow flowers in large terminal panicles and flat maroon colored fruits. It can tolerate a pH. of 5.4—7.6.

A haploid count of 7 *(Fg. 18)* is in line with the base number of 7, but differs from the reports of 2n = 28 (Pantulu 1942 and Sanjappa 1978). Filled Pollen is 98%, and the average grain size is 32.25 μm.

Flower: February—July. Fruit: November—December.

Pterocarpus Jacq.

A tropical genus of 100 species and in Nigeria there are 6 indigenous species and one alien ornamental species.

P. achinatus Pers.

A medium sized tree upto 12m. tall with white flowers. It grows best in neutral to slightly acidic soils (pH 6.9).

The present haploid chromosome count of 11 *(Fig. 19)* confirms the previous report by Sanjappa (1981). Pollen fertility is 98% and the average grain size is 45.15 μm.
Flower: October—March. Fruit: June—August.

Samanea (Bth.) Merrill

A genus of 20 species distributed in tropical regions of Africa and America. There is only one alien species in Nigeria.

S. saman (Jacq.) Merrill

A huge spreading tree upto 30m. tall with short crooked bole. It thrives best in neutral soils.

The present report of 2n = 14 *(Fig. 20)* is a new record for this species. The only other cytologically known species from this genus is *S. dinklagei* with 2n = 26 (Mangenot and Mangenot 1957).

Flower: December—March. Fruit: January—May.

Discussion

The presently investigated ligneous species can be separated into 11 species of *Caesalpinoideae*, 7 species of *Papillionoideae* and 2 species of *Mimosoideae*. Of these 17 species are diploids and three species are tetraploids. The chromosome numbers for 9 species are recorded for the first time and the report of n = 10 for *Hapolormosia monophylla* is a new base number for this genus.

Bauhinia All the previously investigated species except *B. monandra* show a constant number of 2n = 28 and infact there is no chromosomal report which is not a multiple of 7. The present count of 2n = 24 for *B. monandra* indicates a new base number of 12 for this genus.

In *Caragana*, the previous records are based on X = n = 8. The present chromosome number of n = 12 in *C. arborescens* suggests a new base number X = 6 for this genus.

The previously investigated species of *Calliandra* are based on the basic chromosome number of 8. The present report of n = 11 for *C. portoricensis* is suggestive of a new basic number X = 11 for this genus. In *Erythrina* the basic number is 21 and all the previous records are based on this number. The present count of n = 12 in *E. vogelii* indicates the presence of a new basic number of 12 in this genus.

Millettia. Majority of the earlier investigated species like *M. brandisiana* n = 11 (Singhal *et al.*, 1980), *M. ovalifolia* n = 11 (Pal, 1960), *M. peguensis* n = 11 (Rao, *1979*), *M. pendula* n = 11 (Bir and Kumari, 1978), *M. thouninghii* n = 11 (Sarkar *et al.*, 1978) are based on X = 11. However, Atchison (1951) also reported 2n = 20 in *M. ovalifolia* which indicates the presence of a basic number of 10. The present reports of n = 18 *(M. chrysophylla)* and n = 8 *(M. drastica)* are suggestive of new base numbers of 8 and 9 for this genus. The evolution of basic chromosome numbers in this genus may be illustrated as follows:

$$8 \xleftarrow{-1} 9 \xleftarrow{-1} \underset{\text{primary base number}}{10} \xrightarrow{+1} 11$$

Mangenot and Mangenot and Mangenot (1957) reported 2n = 26 in *Samanea dinklagei* and suggested a base number of 13 for this genus. But the present count of 2n = 14 in *S. saman* is suggestive of a base number X = 7. The situation regarding the base number(s) could not be settled unless more species are investigated cytologically. It is quite possible that some species with 2n = 12 might turn up and in that case the origin of X = 13 could be easily explained.

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Variation in Leaf Morphology among Disjunct and Continuous Populations of River Birch (Betula nigra L.)

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Abstract

Leaves from disjunct and continuous populations of river birch *(Betula nigra* L.) were sampled in each of four regions. Analyses based on 18 attributes revealed no apparent morphological trends across the species' range. However, half the attribute means were significantly different among regions and all the attributes were significantly different among local populations. In only one case was an attribute mean significantly different between disjunct and continuous populations. Overall attribute variances were consistently greater than values reported for related species. In each region several attribute variances were significantly different between disjunct and continuous populations. In the Indiana-Illinois, Kansas-Missouri-Oklahoma, and North Carolina-South Carolina regions most of these variances were higher in continuous populations than in their disjunct counterparts. In contrast, the Pennsylvania-New York-Massachusetts region exhibited higher variation in disjunct populations than in the continuous populations. It was concluded that the factors which influence leaf morphology in this species may not be associated with macroclimatic gradients, and that the observed differences may be due largely to the effect of genetic drift in local populations.

Key words: marginal populations, phenotypic variation, *Betula nigra.*

Zusammenfassung

Blätter der Flußbirke aus vier Regionen Nordamerikas wurden gesammelt und gemessen. Die Analyse von 18 morphologischen Merkmalen aller Populationen ergab keine klaren Trends über das untersuchte Verbreitungsgebiet. Es gibt in der Hälfte der Fälle Unterschiede zwischen Regionen und in allen Fällen zwischen örtlichen Populationen. Merkmalsunterschiede zwischen disjunkten und kontinuierlichen Populationen sind kaum zu finden: in nur einem Fall war der Unterschied statistisch gesichert. Die Variationsbreite der Merkmalsmittelwerte zwischen nah verwandten Arten ist durchaus größer als bisher berichtet wurde. In jeder Region gibt es Fälle, in denen die Variationsbreite zwischen disjunkten und kontinuierlichen Populationen unterschiedlich ist. In den Regionen Indiana-Illinois, Kansas-Missouri-Oklahoma und North Carolina-South Carolina ist die Variationsbreite der Merkmale durchschnittlich höher in den kontinuierlichen als in den disjunkten Populationen. In Pennsylvania-New York-Massachusetts wurden jedoch große Variationsbreiten in den disjunkten Populationen gefunden.

Es wird daraus geschlossen, daß Umweltfaktoren, welche die Blattmorphologie beeinflussen, nicht mit makroklimatischen Gradienten zusammen hängen. Die beobachteten Differenzen könnten in hohem Maße auf die Wirkung genetischer Drift in lokalen Populationen zurückgeführt werden.

Introduction

Populations on the margins of a species' range, exhibiting varying degrees of spatial isolation, are important to several models of speciation (COOK 1961, LEWIS 1962, RAVEN 1964, GRANT 1971). While it is generally accepted that these marginal populations differ genetically and ecologically from centroid populations, there is little documentation of this in forest trees. In *Pinus taeda* L., VAN BUIJTENEN (1966) found marginal populations to be highly variable with respect to needle length, cone size, and drought resistance when compared to centroid populations. However, STERN and ROCHE (1974) state that most observations point to less genetic variation in marginal populations than in more centroid populations.

River birch *(Betula nigra* L.), the focus of this study, is an intolerant, pioneer hardwood species common on bottomland sites in eastern North America. Eighteen disjunct populations were reported to exist along the margins of the species' natural range (LITTLE 1971). The objective of the present study was to determine if these populations exhibited less variation than populations within the continuous, more centrally located segments of the range.

Materials and Methods

Using LITTLE's (1971) map of the distribution of river birch, a search for the 18 disjunct populations was initiated. The existence of only four of the eighteen populations was confirmed and served as the basis for sampling *(Table 1)*. The degree of disjunctness of each area from the continu-